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TESTS OF THE WASTE, TENSILE STRENGTH, AND BLEACHING QUALITIES OF THE DIFFERENT GRADES OF COTTON AS STANDARDIZED BY THE UNITED STATES GOVERNMENT.

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ORIGIN AND LOCATION OF THE EXPERIMENTS.

The Department of Agriculture is not interested directly in textile work. Its interest is indirect and arises largely from the fact that Congress has selected it as the governmental agent for the establishment of the official cotton grades and for the study of cotton standardization. Many of the experiments of the department are therefore directed toward ascertaining certain facts that will assist in making the official cotton grades more useful and more reliable.

The official cotton grades at present take cognizance of only two of the important qualities which determine the value of cotton, namely, (1) the color and (2) the amount of trash and waste matter. Any complete system of standardization of cotton will, however, have to take into consideration, among other things, (3) the length of the fiber, (4) the strength of the fiber, (5) the clinging qualities of the fiber, and (6) the bleaching qualities of the fiber. Most of these qualities are of such a nature that they can be satisfactorily determined only by means of spinning tests, and it is for this reason that the department for several years has been making spinning tests with cotton in the mills and textile schools of the country. Experiments have been undertaken, among other places, at the following institutions and mills: Clemson Agricultural College, Textile Department, Clemson, S. C., Lowell Textile School, Lowell, Mass., Mississippi Agricultural and Mechanical College, Agricultural College, Miss., North Carolina Agricultural and Mechanical Textile School, Raleigh, N. C., and at various mills in South Carolina, North Carolina, Missouri, Virginia, Massachusetts, and Maine—about a dozen different mills in all. The experiments consisted in spinning cotton of known history into yarn under definite conditions as nearly as possible approaching commercial conditions. The qualities of the resulting yarn have been tested, and by comparison the desired results have been secured.

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In this way it has been shown how cotton is affected—that is, improved or injured—when grown in certain ways or handled in certain ways.

The last appropriation bill of the Department of Agriculture was so amended in the Senate as to direct the Secretary of Agriculture to make tests as to the waste, tensile strength, and bleaching qualities of the various grades of cotton as established by the Government.

These experiments are being conducted in part at the Riverside and Dan River Cotton Mills, at Danville, Va., and are being so carried out as to reserve at each stage of the manufacture a liberal supply of the material. It is intended that this reserve shall be used in making 50 sets of exhibits to accompany the full report. Each exhibit will consist of 25 to 50 boxes or cases containing samples of waste, sliver, roving, yarn, etc., of such size that their commercial qualities can be estimated by those versed in the art. It is intended to distribute these exhibits in such a way as to make them accessible to growers, buyers, manufacturers, and educational institutions.

COTTON USED IN THE EXPERIMENTS.

In making these waste, tensile strength, and bleaching tests of the official grades of cotton, only the grades Middling Fair, Good Middling, Middling, Low Middling, and Good Ordinary have been used. This method makes it possible to test a larger number of bales of the respective grades and so gives a more accurate average. The qualities of the intermediate grades may then be interpolated. Since there is some difference in the spinning characteristics of eastern and western Upland cotton, the test has been divided into two parts. From 50 to 60 bales of the two respective growths, or an aggregate of 100 to 120 bales have been selected; that is, 10 to 12 bales of each grade of both Atlantic States Upland and Western Upland cotton. In order that the tests may be comparative, each lot has the same length of staple—1 inch. There is probably more staple produced which is fifteen-sixteenths of an inch to 1 inch than any other one length in both the eastern and western Upland cotton. The term "Western Upland" as here used includes practically all cotton grown west of Alabama, except long-staple river-bottom cotton.

The cotton was secured in June, 1913, from the following places:

Greenville, S. C., 6 bales, Atlantic States Upland cotton.
Seneca, S. C., 5 bales, Atlantic States Upland cotton.
Atlanta, Ga., 34 bales, Atlantic States Upland cotton.
Atlanta and Montgomery, 18 bales, Atlantic States Upland cotton.
New Orleans, La., 9 bales, Western Upland cotton.
Mobile, Ala., 32 bales, Western Upland cotton.
Memphis, Tenn., 5 bales, Western Upland cotton.
Lesser-Goldman, St. Louis, Mo., 12 bales, Western Upland cotton.
New Orleans, La., 2 bales, Western Upland cotton.

The cotton thus secured has been supplemented by a few bales from other sources. This cotton was shipped early in July to Danville, Va., where all of it was stored on the same warehouse floor and allowed to stand until October 1, so that the bales, in spite of their varied origin, might come to the same condition as to moisture, etc.

Thirty-five pounds from each bale have been sent to the textile department of Clemson Agricultural College, Clemson, S. C., and 35 pounds to the North Carolina Agricultural and Mechanical Textile School at Raleigh, N. C. Thirty pounds of each bale are to be reserved for use in the preparation of record sets.

The 10 to 12 bales of each grade remaining at the Danville mills have been thoroughly mixed and allowed to stand for a day or two just before entering the beaters. A composite sample was taken from each lot of 10 to 12 bales so mixed, and this was sent to Washington for accurate tests of various kinds.

MILL CONDITIONS OF THE EXPERIMENTS.

The same number of yarn (20–22) has been made at the mill from each grade, using the regular mill machines and methods, with the speeds, settings, relative humidity, and other factors the same for each grade of cotton. The organization and other figures were determined after consultation with a number of representative American mills, the officers of which generously undertook to examine and comment on the figures first determined upon by the experts of the Department of Agriculture, Messrs. D. E. Earle and W. S. Dean. In this way mill conditions representative of American practice were secured, as shown in Table I.

TABLE I.—*Organizations, speed, and settings used with regular mill machines for five official cotton grades.*

ORGANIZATIONS.[1]

No. of yarn.	Card.		Drawing, grains per yard.	Slubber, hank.	Intermediate, hank.	Roving, hank.	Spinning, doubling.
	Lap, ounces per yard.	Sliver, grains per yard.					
12	16	65	60	0.55	1.6	.....	1
16	14	60	60	.55	1.4	2.6	1
22	13	52	52	.47	1.16	3.33	1
28	12	50	50	.75	1.7	5.4	2
36	10	45	45	.80	2.2	6.5	2

[1] These figures, of course, do not refer to mills devoted to specialties.

TABLE I.—*Organizations, speed, and settings used with regular mill machines for five official cotton grades*—Continued.

SPEEDS (R. P. M.).

Machine.	No. 12's from Good Ordinary.	No. 16's from Low Middling.	No. 22's from Middling.	No. 28's from Good Middling.	No. 36's from Middling Fair.
Opener beater (3-blade)	1,170	1,170	1,170	1,170	1,170
Breaker beater (2-blade)	1,460	1,460	1,460	1,460	1,460
Fan	1,260	1,260	1,260	1,260	1,260
Intermediate beater (2-blade)	1,460	1,460	1,460	1,460	1,460
Fan	900	900	900	900	900
Finisher beater (2-blade)	1,460	1,460	1,460	1,460	1,460
Fan	900	900	900	900	900
Card cylinder	165	165	165	165	165
Doffer	13	13	12	12	12
Drawing, calender roll	315	315	315	315	315
Slubber F. R., 11×5½	195	192	192	175	130
Intermediate F. R., 9×4½	182	182	160	157	150
Fine-frame F. R., 7×3½		180	130	130	120
Spinning F. R.	150	140	120	114	108
Spindle	7,500	8,000	8,200	9,000	9,000

SETTINGS.

Machine.	No. 12's from Good Ordinary.	No. 16's from Low Middling.	No. 22's from Middling.	No. 28's from Good Middling.	No. 36's from Middling Fair.
	Inch.	*Inch.*	*Inch.*	*Inch.*	*Inch.*
Opener-feed roll to beater	$\frac{5}{8}$				
Grids from beater (top)	1	1	1	1	1
Grids from beater (bottom)	$1\frac{1}{2}$				
Breaker-feed roll to beater	$\frac{1}{4}$				
Grids from beater (top)	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$
Grids from beater (bottom)	1	1	1	1	1
Intermediate-feed roll to beater	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{4}$
Grids from beater (top)	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$
Grids from beater (bottom)	1	1	1	1	1
Finisher-feed roll to beater	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{4}$
Grids from beater (top)	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$
Grids from beater (bottom)	1	1	1	1	1
Card:	*Gauge.*	*Gauge.*	*Gauge.*	*Gauge.*	*Gauge.*
Feed plate to licker in	10	10	10	10	10
Mote knives (top)	12	10	10	10	10
Mote knives (bottom)	10	12	12	12	12
Licker in to cylinder	10	10	10	10	10
Back plate to cylinder	22	22	22	22	22
Flats to cylinder (back)	11	11	11	11	11
Flats to cylinder (center)	10	10	10	10	10
Flats to cylinder (front)	9	9	9	9	9
Front plate to cylinder	29	22	22	22	22
Doffer to cylinder	7	7	7	7	7
Doffer comb to doffer	22	22	22	22	22
Licker in screen (front)	125	125	125	125	125
Licker in screen (back)	22	22	22	22	22
Cylinder screen (back)	22	22	22	22	22
Cylinder screen (center)	70	70	70	70	70
Cylinder screen (front)	125	125	125	125	125
Drawing (2 processes)	$1\frac{3}{8}, 1\frac{1}{2}, 1\frac{5}{8}$	$1\frac{3}{8}, 1\frac{1}{2}, 1\frac{5}{8}$	$1\frac{3}{8}, 1\frac{1}{2}, 1\frac{5}{8}$	$1\frac{3}{8}, 1\frac{1}{2}, 1\frac{5}{8}$	$1\frac{3}{8}, 1\frac{1}{2}, 1\frac{5}{8}$
Slubber rolls	$1\frac{1}{8}, 1\frac{3}{8}$	$1\frac{1}{8}, 1\frac{3}{8}$	$1\frac{1}{8}, 1\frac{3}{8}$	$1\frac{1}{8}, 1\frac{3}{8}$	$1\frac{1}{8}, 1\frac{3}{8}$
Intermediate rolls	$1\frac{1}{8}, 1\frac{3}{8}$	$1\frac{1}{8}, 1\frac{3}{8}$	$1\frac{1}{8}, 1\frac{3}{8}$	$1\frac{1}{8}, 1\frac{3}{8}$	$1\frac{1}{8}, 1\frac{3}{8}$
Fine fly frame rolls	$1\frac{1}{8}, 1\frac{3}{8}$	$1\frac{1}{8}, 1\frac{3}{8}$	$1\frac{1}{8}, 1\frac{3}{8}$	$1\frac{1}{8}, 1\frac{3}{8}$	$1\frac{1}{8}, 1\frac{3}{8}$
Spinning rolls	$1\frac{7}{16}, 1\frac{1}{4}$	$1\frac{7}{16}, 1\frac{1}{4}$	$1\frac{7}{16}, 1\frac{1}{4}$	$1\frac{7}{16}, 1\frac{1}{4}$	$1\frac{7}{16}, 1\frac{1}{4}$

In spite of the fact that some of the grades would rarely be spun into yarn of these sizes, it was thought best for various reasons to spin all the grades into one size of yarn at the Danville mill. The same cotton will be used in smaller quantities at the two textile schools and spun as nearly as possible under the same conditions. At one of the schools the mill tests will be duplicated; at the other a varia-

tion will be introduced, in that each grade will be used to spin the size of yarn for which it is best adapted, so that when the entire series of experiments is completed the results will present as many sided a view of the question as possible.

Approximately two bales of each grade have been bleached in the raw and the same number of yarn made from each bleach at Danville. With the exception of one bale of western Good Ordinary no difficulty was encountered in bleaching.

About 25 pounds of waste, or as much thereof as is produced on the different machines for the respective grades, have been marked and sent to Washington, where waste types will be prepared for the determination of value. For careful examination, as well as for exhibition purposes, the following types of waste have been collected from each of the 10 tests:

About 25 pounds of opener and breaker lapper motes.
About 25 pounds of intermediate lapper motes.
About 25 pounds of finisher.
About 25 pounds of card strippings.
About 25 pounds of card toppings.
About 25 pounds of card flyings and motes.

A record of the white waste made in spinning the respective grades has also been made, as well as the scavenger and clearer waste. Hygrometers have been placed in the various mill rooms and readings made hourly. A relative humidity of about 55° for the picker and card rooms and 65° for the spinning room has been maintained so far as practicable.

NATURE OF THE COTTON SECURED FOR THE EXPERIMENTS.

No serious difficulty was encountered in securing in the month of June, 1913, sufficient cotton for both of these tests. It was, of course, necessary, considering the nature of the experiment, that each bale of cotton be of very uniform character and exactly of the specified grade. It was not deemed wise to accept a lot of 10 or 12 bales which would merely average the specified grade. No bale was accepted unless, when the bands were removed and the bale opened up and sampled in 12 different places, it proved to be of very uniform character. Purchasing cotton in this way is a very different matter from purchasing an average lot for ordinary mill purposes, where considerable latitude can be allowed so long as the average of the purchase is about on grade. Nevertheless, as before stated, no very great difficulty was encountered. In Low Middling Atlantic States Upland cotton it was necessary to accept a few bales of a slightly bluish cast, differing to a small extent in color from the box types of the official grades. Samples drawn from the accepted bales have been inspected by dozens of well-known experts from all parts of the

cotton-growing and cotton-manufacturing regions of the United States, and these experts without exception declared the bales to be excellently selected.

While this cotton is now well through the mill, so that the success of the experiment is assured, it is not yet possible to draw more than tentative and approximate conclusions on a number of points. It seems safe, however, to make the following statements.

PERCENTAGE OF WASTE.

The two classes of cotton, Western Upland and Atlantic States Upland, have yielded a visible waste of slightly different weight and character, the average difference in the percentage of waste being between 1 and 2 per cent, taking all the grades into consideration. This difference obtained in the mill has been paralleled by carefully made hand separations. In the hand separations, the average difference in waste was about $1\frac{3}{4}$ per cent. On the whole, as would be expected, the differences are considerably greater in the lower grades than in the higher grades. The highest difference so far noted was the following, but so large a difference appears altogether exceptional.

Visible waste (hand separated).—Atlantic States Upland Good Ordinary, 12.49 per cent; Western Good Ordinary, 7.80 per cent.

Mill waste (visible).—The corresponding minimum difference was as follows: Atlantic States Upland Good Ordinary, 12.57 per cent; Western Good Ordinary, 10.08 per cent.

VALUATION OF THE WASTE.

The value of the visible waste from the various grades has yet to be determined, but from its character there can be little doubt that the valuation figures for the waste of the two classes of cotton will be approximately equal, weight for weight.

TENSILE STRENGTH OF THE YARN.

Preliminary and approximate figures have been obtained concerning the tensile strength of the yarns. These tests show the yarn from the two classes of cotton to be about equal in strength.

As regards the relative amount of visible waste in the different grades, the figures are found to be more consistent than might have been expected. The mill waste in the experiments to date varies from about 4 per cent in Middling Fair to about 11 per cent in Good Ordinary, and the various official grades tested fall into line with something approaching mathematical uniformity, as will be seen by examination of the following graph (fig. 1).

LENGTH OF STAPLE USED.

It must be carefully borne in mind that the cotton used in these investigations was all of the same length of staple. It will be seen from an examination of the purchasing sources that most of the Atlantic States Upland cotton has probably come from the Piedmont and similar sections. An examination of the Census Bureau statistics for the last five years indicates that about half of the Atlantic States Upland cotton of the character used in these experiments originates in these sections. The other half of the cotton used in the tests came from the Gulf States and Arkansas.

CONDITIONS UNDER WHICH THE EXPERIMENTS WERE MADE.

Although the foregoing figures and statements are the result of experiments on only one season's cotton, they are presented with confidence in their approximate accuracy so far as they go. The investigations have been carried out under favorable auspices and

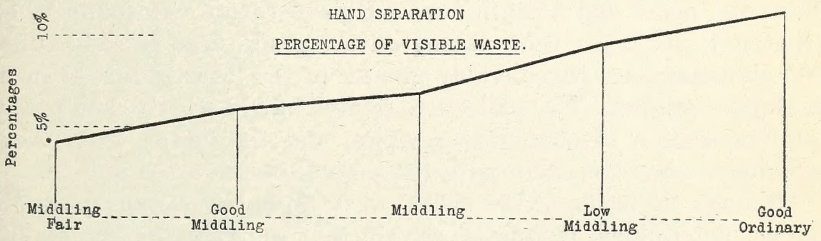

FIG. 1.—Graph showing the percentage of visible waste in five of the official cotton grades. The waste in this case was obtained by hand separation.

have been attended with good fortune. The only exception to this has been that unsuitable weather occurred during a part of the spinning. No detail received greater attention than that of suitable and uniform humidity. Among other precautions taken was the halting of the experiments for three months in order that the work might be done during the most suitable spinning months for the region (Danville, Va.), namely, those of October and November. Hence, the mill experiments began on October 1, 1913.

Unfortunately, however, the weather during the first weeks of October was about the most varied that had ever been experienced at Danville. Everything was done to offset this disadvantage by as careful control of the humidifiers as possible. Furthermore, the precaution of reserving 200 pounds of each grade somewhat short of the spinning stage had been observed, and it was possible later to put this weight of each grade through the spinning processes on the same day, thus securing a relatively small amount of yarn more strictly comparable than would otherwise have been possible. The final figures will be ready for publication in the course of a few months.

SUMMARY.

In accordance with the last appropriation bill of the Department of Agriculture, tests as to the waste, tensile strength, and bleaching qualities of the different grades of cotton as established by the Government have been carried on in order to ascertain certain facts which would make the official cotton grades more useful and reliable.

About 10 or 12 bales of each of the five grades Middling Fair, Good Middling, Middling, Low Middling, and Good Ordinary, of both Atlantic States Upland and Western Upland cotton of 1-inch staple, were secured early in July, 1913. This cotton was stored at the Riverside and Dan River Cotton Mills, Danville, Va., where the experiments started on October 1. The Danville tests will be supplemented by additional experiments made on a certain quantity of the same cotton which has been sent to the textile department of Clemson Agricultural College, Clemson, S. C., and to the North Carolina Agricultural and Mechanical Textile School, at Raleigh, N. C.

The average difference in percentage of visible waste between Western Upland and Atlantic States Upland cotton was found to be between 1 and 2 per cent, taking all the grades into consideration. The differences are considerably greater in the lower grades than in the higher grades. The mill-waste figures have been checked up by hand separation of composite samples, and the figures from these experiments are consistent with those obtained from the mill.

Although the value of the visible waste from the various grades is not yet determined, it appears certain that the valuation figures for the waste of the two classes of cotton will be approximately equal, weight for weight.

Preliminary figures show the yarn from the two classes of cotton to be about equal in strength.

The mill waste in the experiments to date varies from about 4 per cent in Middling Fair to about 11 per cent in Good Ordinary, while the figures for the other grades are more or less consistent.

At the close of these experiments exhibits made from the material reserved at each stage in the manufacture will be made to accompany the full report.

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